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CONSULTANTS IN ACOUSTICS, VIBRATION & AUDIOVISUAL SYSTEM DESIGN

BEULAH ROAD PROPERTY

VIENNA, VIRGINIA

Noise Mitigation Processes and Monitoring at Leaf Processing Facility

Project Number 04-144

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INTRODUCTION

This report is provided to summarize results of the noise mitigation and monitoring of the leaf processing activities conducted at the Beulah Road property. The noise monitoring was requested as a follow up for a noise mitigation program that was begun last year and described in the Miller, Beam & Paganelli report of April 22, 2005. The first stage of the noise mitigation was to install a custom sound reduction enclosure around the grinder. The previous report described measurements of noise levels around the Beulah Road mulch site of the grinder and leaf mulching operation both before and after the installation of the enclosure, which was shown to provide a considerable reduction in noise produced by the grinder. In addition, average daily noise levels were reduced by limiting the number of hours the grinder could operate.

Between the 2004-05 and 2005-06 leaf mulching seasons, a noise barrier was constructed around three sides of the mulching site. This was done to reduce the noise of the mobile noise sources, primarily the trucks and front end loaders and their back-up warning alarms. It was noted in earlier surveys that the piles of leaves themselves provided shielding to some locations along the property lines. However, the noise reduction provided by the leaf piles varied as their size and locations shifted and the vehicles moved around the site. The barrier was designed to provide continuous noise mitigation to the surrounding community regardless of leaf distribution or the movement of vehicles around the site. The barrier also provides further reduction of the grinder noise.

NOISE MONITORING

The first of the monthly surveys was conducted on October 25th 2005. On this date four sound level meters were used to make a continuous series of measurements at two locations at both ground level (5 ft) and upper story (approximately 15-18 ft). The two locations were the northwest corner of the property and near the middle of the west property line at the sewer access roadway. For convenience of reference, and in accordance with the site plan, the side of the property bordering Beulah Road is referred to as the East side with the North, West, and South sides closest to Broadleaf Road, Holloway Court, and Sherwood Drive, respectively, although these streets do not truly run east-west and north-south. The approximate measurement locations are shown in Figure 1.

In October, at the beginning of the mulching season, the only activity at the Beulah Road site was dumping of the leaves. Based on conversations with personnel at the site, three trucks were being used to collect the leaves. Due to the limited number of leaves available, each truck delivered only 1-3 loads of leaves to the site per day. On the day of the noise motoring, while at the site between roughly 10 am and 3 pm, only two truck loads of leaves were delivered, both within the same half hour period.

The activity began with a truck arriving. The stopped truck would idle as the leaf vacuum (the device that blows the leaves into the top of the truck) was detached. The truck then drove toward the leaf pile, backing into position. After the leaves were dumped, the vacuum was reattached to the truck. The process lasted roughly 10 minutes. The second truck stayed an estimated five minutes longer than the first while compressed air was used to clean a filter.

The trucks produce a low frequency rumbling noise while moving and idling. The higher frequency backup alarms were sounded for a few seconds as the truck backed into the pile and again backing up for reattachment of the vacuum. Overall the alarms operated for well less than a minute.

Figure 2 shows the average and maximum noise levels measured, in a series of 5 minute periods, at the two locations. The approximate times of the trucks entering and leaving the site are indicated. No data was recorded between 1:20 and 2:20 at the West location at ground level due to exhausted battery.

Measuring the noise produced by short term, intermittent (two dumping events in five hours) noise sources at multiple locations and heights can be a difficult process. It requires a team of technicians, each with measurement equipment, stationed at each desired measurement location throughout the day waiting for the desired activity to occur while other unwanted events, such as aircraft passing over head, does not occur. This is made more difficult at the Beulah Road site because of the large size of the site, its vegetation which slows movement around the site, and its topography and barrier which blocks visual confirmation of the source of the noise being measured.

Subsequent surveys consisted of measuring noise levels at five locations around the property boundary. These five locations are indicated in Figure 1.

One monitoring survey was conducted per month. Measurement dates and times were chosen randomly in relation to mulching activity at the site. However, during the grinding stage, measurements were specifically taken while the grinder was in operation. Measurements were made on days with good weather (no precipitation, low winds) to accommodate the measurements. The time of the surveys were generally in the late morning or early afternoon.

Measurements were simultaneously made at two heights. The ground level elevation was approximately 5 ft above grade. The upper elevation measurement was accomplished by placing the microphone atop an extendable pole and raised to a height approximately 15-18 ft above grade.

Tables showing the maximum, minimum, and energy-equivalent average level (L_{eq}) are provided for each of the 2005-2006 dates, along with a summary of activity at the site. Two tables showing the 2004-2005 measured noise levels from the April 22, 2005. report are also included.

RESULTS

When evaluating the following results, it is important to understand that the decibel (dB) scale, upon which sound level measurements are based, is logarithmic. A 3 decibel change (increase or decrease) is equal to a factor of 2 in energy (such as changing an audio amplifier from 5 watts to 10 watts, or vice versa), but to the human ear is only slightly perceptible. A change of 10 dB represents a factor of 10 change in energy (5 watts to 50 watts, or vice versa) and is subjectively twice (or one-half) as loud. The A-weighted decibel level (dBA) is the most universally used single number for rating human reaction to sound. The dBA scale approximates the ear's response to sound by discounting the low and highest frequency sounds where our ears are less sensitive and emphasizing the middle to high frequencies where our ears are most sensitive.

As would be expected, the noise from leaf moving and grinding operations are loudest at locations closest to the activity at the north property line. Noise levels at the property line closest

to the grinder (311 Broadleaf Rd) were reduced by 10 dBA from 73 dBA to 63 dBA with the addition of the grinder engine enclosure. As noted above, subjectively this represents a reduction in loudness by one half. The January 2006 measured noise levels at this location, including the noise mitigation provide by the barrier, were 56 dBA, or subjective less than a third of the unmitigated noise level. February 2006 measured noise levels at this location were 60 dBA, skewed higher due to the entrance of a truck only partially shielded by the barrier. However, both measurements represent a significant reduction in noise from the leaf processing operation.

At other locations around the site, further from the leaf processing activities where other background community noises influenced the overall noise levels, the effects of the barrier and grinder enclosure are more difficult to quantify. Before the construction of the barrier, piles of leaves were observed to provide noise shielding to some locations. The barrier was designed to provide continuous noise mitigation to the surrounding community regardless of leaf distribution. The barrier provides consistent shielding of sources, especially from the moving noise sources such as trucks and front loaders and their back-up alarms. With only a few exceptions, the difference in noise levels between ground and upper heights were 2 dBA or less.

As shown in Figure 2 (the 5-minute average and maximum noise levels between 11 am and 3 pm), the average noise levels at the west side of the property without leaf processing activity were most often between 50 and 55 dBA, although regularly above 55 dBA, and as high as 62 dBA. These levels are consistent with the randomly timed spot measurements made around the site. Noise from the site was audible; specifically, in the low frequency range (50-80 Hz) of the truck and front end loader engines and the tonal frequencies (1 - 1.25 kHz) of the back-up warning alarms. Noise levels at the east side were usually louder than the rest due to noise from traffic on Beulah Road. The noise produced by occasional trucks dumping leaves at the site contributes very little to the overall daily noise exposure. It is our understanding that when the grinder is operating and thus the noise from the site is continuous, the operational hours are restricted to reduce the overall daily noise load.

It is our understanding there also was some concern expressed that the noise levels produced by the leaf processing operations were loud enough to damage hearing. According to the Occupational Safety and Health Administration (OSHA) standards, an 8-hour average noise exposure of 85 dBA is considered the "actionable" level above which noise monitoring or mitigation measures may be necessary. An 8-hour average noise exposure of less than 85 dBA is considered not to be a risk to hearing loss. Near the property line of the Beulah noise site, average noise levels of leaf processing activity and community background noise were closer to the 50-55 dBA range, or 30-35 dBA less than the potential risk level. Thus, noise due to leaf processing activity at the property line and beyond are substantially less than the potential hearing loss risk levels.

CONCLUSION

Noise mitigation measures have been implemented in order reduce the noise from the leaf processing operations from the Beulah Road property to the surrounding community. In the 2004-2005 season a custom silencer / enclosure was constructed to reduce the noise from the grinder. Before the 2005-2006 season, a noise barrier with a sound absorbing liner was constructed around three sides of the processing area to further reduce the noise from the grinder and from mobile sources (trucks, front end loaders, etc.) and their back-up warning alarms. The combination of these measures were found to reduce the noise at the most noise impacted locations to a third (13-17 dBA) of the unmitigated levels. Noise levels at more distant locations were similarly reduced a significant amount, although often were controlled by background sources. Finally, the hours that leaf grinding operations could be performed were restricted to reduce the overall daily noise load produced at the site.

BUELAH ROAD DATA TABLES
October 26, 2005: See Figure 2

November 28, 2006

Measurement Location	Height	Measured Noise Levels (dBA)			Notes
		Average	Maximum	Minimum	
1: North	Ground	52	61	49	Truck unloading. Loudest noise is truck bed door slam
	Upper	52	62	50	
2: NW	Ground	47	50	46	Trucks presumed to be at site.
	Upper	48	50	47	
3: West	Ground	48	56	46	No noticeable noise from site. Nearby resident w/ circ saw.
	Upper	50	58	48	
4: South	Ground	49	54	47	No noticeable noise from site.
	Upper	50	54	47	
5: East	Ground	55	60	47	No trucks at site. Traffic is dominant noise source.
	Upper	59	64	48	

Trucks unloading leaves. Three trucks in operation, not all on site at once. Trucks arrive, dump leaves, and leave. No vacuum equipment on trucks, so events are shorter than previous month as time is not taken removing the equipment.. Single event lasted ~ 2-3 minutes. Primary noise during operation is truck engine noise. Back-up warning alarm is short (~10 sec) as trucks back into pile. Rear gate of truck slams closed after dumping producing noise levels of 61 dBA at north measurement location.

Helicopter 85 dBA
North: backup warning alarm ~45 dB @ 1.25 kHz

December 19, 2005

Measurement Location	Height	Measured Noise Levels (dBA)			Notes
		Average	Maximum	Minimum	
1: North	Ground	49	59	49	No activity on site.
	Upper	49	54	45	
2: NW	Ground	49	56	49	No activity on site. Planes
	Upper	50	59	44	
3: West	Ground	44	56	39	No activity on site. Distant planes. Distant siren.
	Upper	45	52	41	
3:West	Ground	49	59	45	Truck(s) arrive. Truck and front end loader activity.
	Upper	50	60	45	
3: West (3:30)	Ground	51	58	46	Truck and front end loader. Truck leaves
	Upper	52	57	47	
4: South	Ground	48	55	42	Front end loader activity ended
	Upper	48	54	43	
5: East	Ground	57	73	49	Truck at site. Truck leaves, passes meters at 4:45 of 5:00 period (73 dBA)
	Upper	62	67	51	

Trucks unloading. Front end loader moving leaves. While at the west location a truck arrived. Both the front end loader and truck were operating until truck left. Front loader stopped about 5 minutes after truck left. Total length of activity was 15 minutes.

January 27, 2006

Measurement Location	Height	Measured Noise Levels (dBA)			Notes
		Average	Maximum	Minimum	
1: North	Ground	56	60	55	Grinder / front end loader activity throughout. Distant dog.
	Upper	58	61	56	
2: NW	Ground	49	54	47	
	Upper	50	53	49	
3: West	Ground	55	61	50	2-3 close dogs barking
	Upper	60	65	52	
4: South	Ground	50	55	48	
	Upper	51	54	49	
5: East	Ground	52	56	47	Road noise
	Upper	55	59	49	

Grinder is in operation. Noise from grinder and associated activity is fairly constant with occasional back up warning alarms. Note that measurement period is reduced to two minutes so measurement can be made at all five locations before grinder is shut down for day.

February 10 and 16, 2006

Measurement Location	Height	Measured Noise Levels (dBA)			Notes
		Average	Maximum	Minimum	
1: North	Ground	60	66	57	Grinder, front end loader, truck enters site
	Upper	62	68	60	
2: NW	Ground	52	58	51	Grinder, front end loader, maybe truck
	Upper	53	56	52	
3: West	Ground	53	63	49	Grinder, two front end loaders
	Upper	54	62	50	
4: South	Ground	56	59	53	Grinder, two front end loaders
	Upper	56	60	54	
5: East	Ground	61	76	54	2 trucks enter
	Upper	62	75	55	

Grinder stopped at 1:30 on 2/10, only 2 of 5 sites measured. Return on 2/16 for other 3.
Back-up warning alarm 5-10 dB @ 1.25 kHz above ambient noise level at North property line.
Closer to 5 dB @ 1.25 kHz above ambient at NW

March 27, 2006

Measurement Location	Height	Measured Noise Levels (dBA)			Notes
		Average	Maximum	Minimum	
1: North	Ground	49	56	40	
	Upper	50	59	42	
2: NW	Ground	45	65	34	
	Upper	45	61	36	
3: West	Ground	51	58	48	
	Upper	54	58	51	
4: South	Ground	48	58	40	
	Upper	49	54	41	
5: East	Ground	52	61	40	
	Upper	55	64	42	

No mulching related activity at site.
Noise sources are mostly birds, distant traffic, and occasional unknown distant construction activity south of site.

2004 - 2005 BEULAH ROAD PROPERTY LEAF MULCHING
Measured Noise Levels

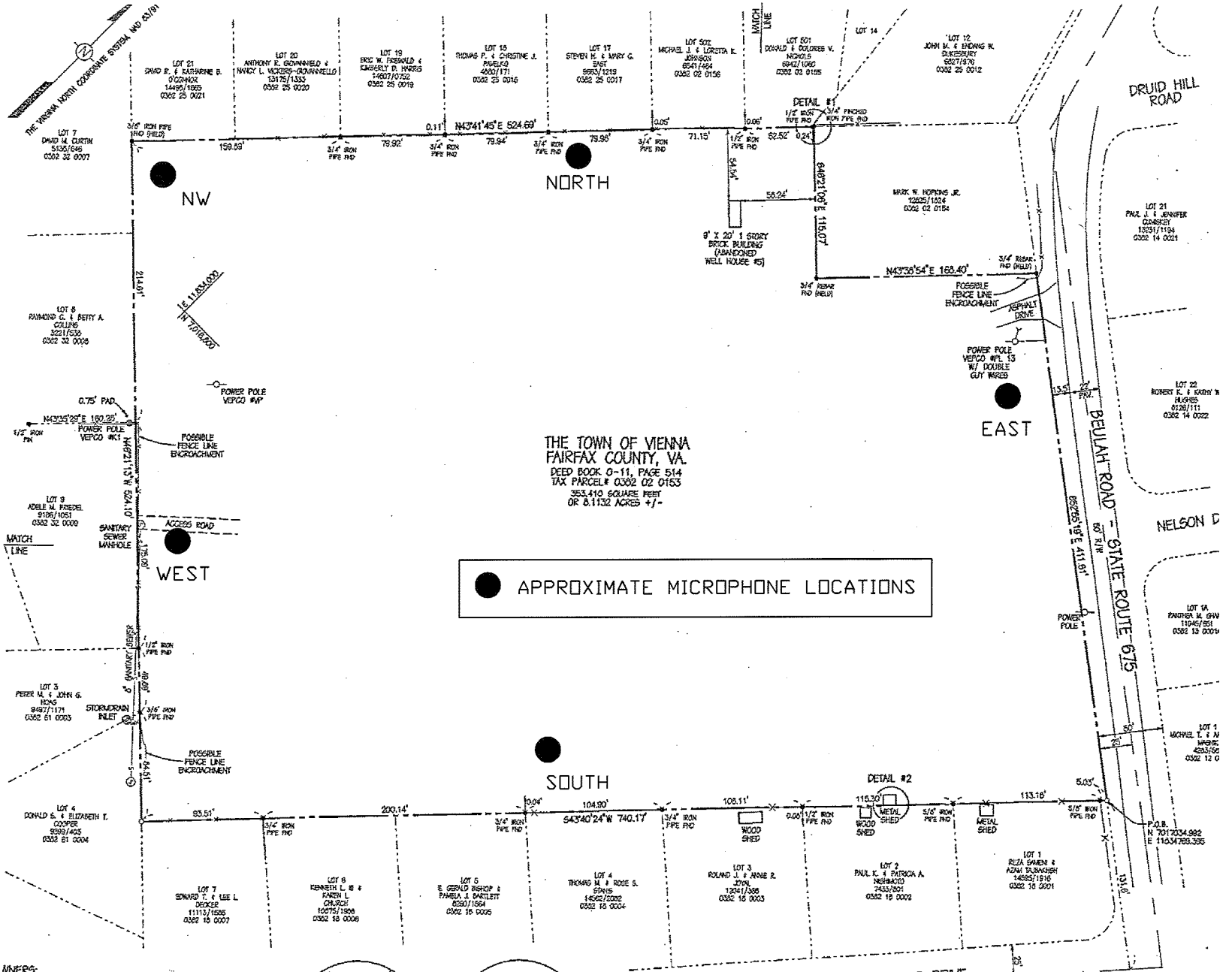
MEASUREMENT LOCATION [1]	AVERAGE NOISE LEVEL [2] (dBA)	
	Jan 6th no grinder enclosure	Jan 27th with grinder enclosure
311 Broadleaf Rd (NORTH)	73, 71	63
315 Broadleaf Rd	67	57
317 Broadleaf Rd	59	51
319 Broadleaf Rd / 403 Holloway Ct (NW)	57, 57	49
405 Holloway Ct	60	53
407 Holloway Ct (WEST)	57, 55	53
320 Sherwood Dr	59	56
322 Sherwood Dr	54	
324 / 326 Sherwood Dr (SOUTH)	56	54
328 / 330 Sherwood Dr	54	50

TABLE 6

[1] Measurements were made near the rear property line of the noted addresses.
[2] Nominal 2 minute period.

Location	Activity	Average Noise Level (dBA)
On site, NE of work area	Ambient (5 min)	50, 49
311 Broadleaf Rd	Front loader and small truck	61
311 Broadleaf Rd	Front loader idling (some shielding)	50
313 Broadleaf Rd	Front loader idling	53
319 Broadleaf Rd / 403 Holloway Ct	Front loader and large truck	52-54

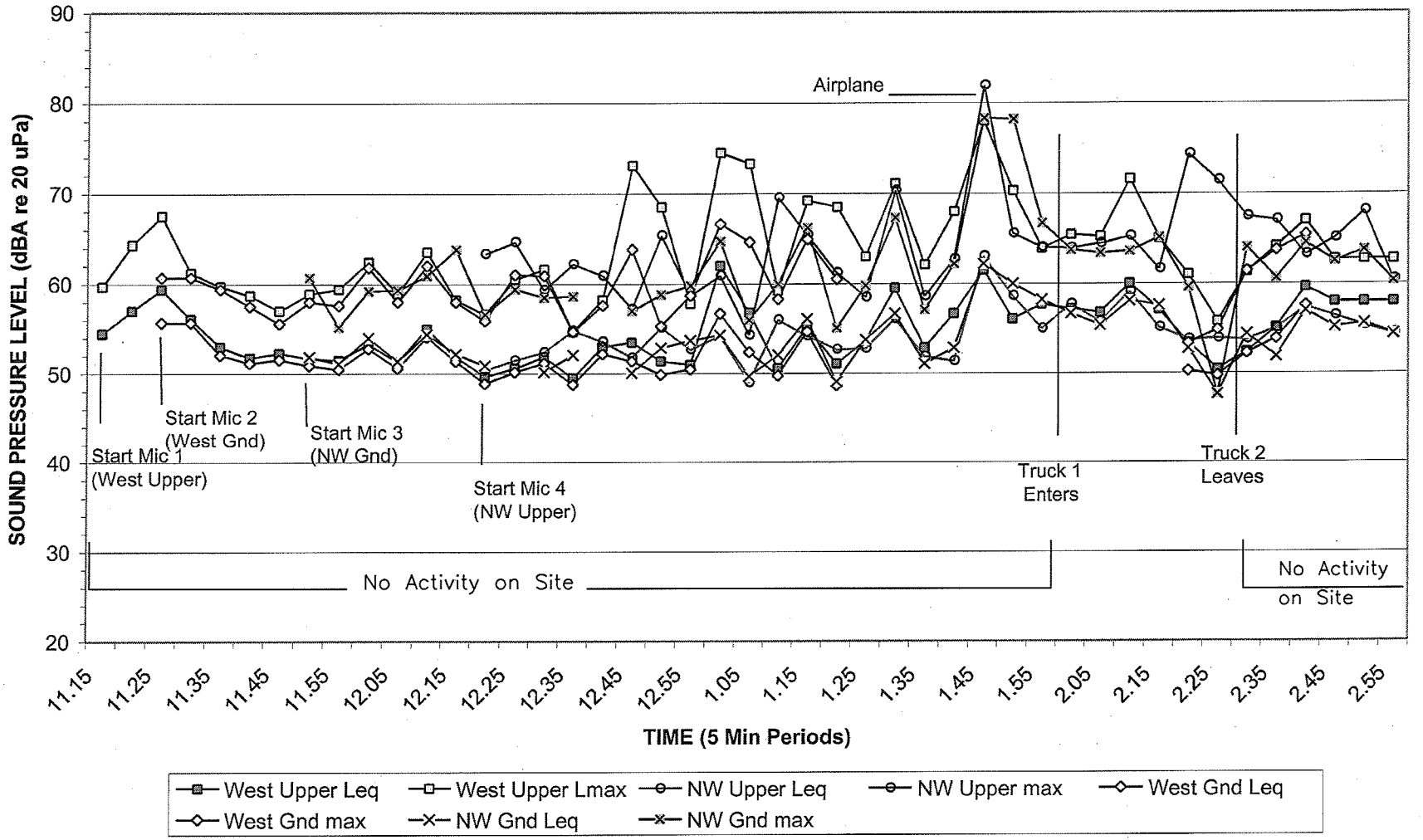
TABLE 7



MILLER, BEAM & PAGANELLI, INC.			PROJECT: BEULAH ROAD LEAF PROCESSING	SHEET:
FIGURE: 1	DATE: 6/28/06	SCALE:	TITLE: NOISE MONITORING LOCATIONS	OF:

AVERAGE (Leq) AND MAXIMUM (Lmax) MEASURED NOISE LEVELS

OCTOBER 26, 2005



MILLER, BEAM & PAGANELLI, INC.			PROJECT: BEULAH ROAD LEAF PROCESSING	SHEET:
FIGURE: 2	DATE: 6/28/06	SCALE:	TITLE: NOISE MONITORING RESULTS	OF: